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Promotion strategies for renewable energy in Taiwan

Falin Chen, Shyi-Min Lu*, Wang Chi-Chuan, Yi-Lin Chang

Energy and Environment Research Laboratories, Industrial Technology Research Institute, Chutung, Hsinchu, 310, Taiwan

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Abstract

To promote the development and application of renewable energy, under the planning and execution of Bureau of Energy of Ministry of Economical Affairs (BOEMOEA), Taiwan has implemented many measures for subsidizing the installation of RE apparatus since 2000. Besides subsidizing the installing expenses, Taiwanese government also provides incentive measures of finance/tax, such as investment deduction and accelerating depreciation. The successive growth of the amount of installing cases has apparently constructed the base of promotion and application of renewable energy; on the other hand, many barriers to be overcome were continuously discovered during the executing processes. To effectively remove these promoting barriers, the Energy Commission (the pre-BOE) issued "Renewable Energy Development Plan" through the endorsement of Executive Yuan in January 2002. The purpose of this plan is to establish an inter-ministerial coordinating mechanism of a higher administrative level, which may focus all resources to be functioned as a working team. In the meantime, to further establish a systematically promoting mechanism, the Bureau of Energy then pushes the legislation of "Renewable Energy Development Bill". According to the drafted plan of this law, the power capacity of renewable energies will be 12% share of the national power installation capacity by 2020. Furthermore, in the Nuclear-free Homeland National Conference held in June 2003, government planned that the power capacity of renewable energy must reach 10% of the total power capacity in the nation by 2010. However, the share of the power capacity of renewable energy to the national power installation capacity is only 6.17%, currently, so there is still a lot of growing space for the development of renewable energy in Taiwan.

Keywords: Renewable energy; Promotion strategy; Taiwan

*Corresponding author. Tel.: +886 3 5914218; fax: +886 3 5829782.
E-mail address: shyimin@itri.org.tw (S.-M. Lu).

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Contents

1. Introduction

After the industrial revolution, traditional fossil energy had been explored and adopted in great amount, so it is gradually depleting (please refer to Table 1, which shows the global reserves and remaining available years of major fossil energies) right now. In the meantime, since of the impacts on environment caused by the application of traditional energies, such as: green-house effect and environmental pollution, etc., so how to reduce the dependence on traditional energy and the damage on our environment but, in the meanwhile, sufficient energy being able to supply to fulfill the needs of both economics and livelihood, have become the biggest issue for human being. Renewable energies are sustainable and clean energies, which may overcome the gradual depletion of traditional fossil energies that have impacts on environment, and which may also solve the issues of energy sustainability, economical development, and environmental protection, so the development and application of renewable energies had been accelerated in last decade.

According to the international news on 14 July 2006, the international price of oil had been surged over 77 US dollars per barrel [2], and the international price of coal also reached 74 US dollars per ton [3], and it is expected that they will keep on rising. These high prices of energies have enormous impact on Taiwan, which imports over 98% of energy supply from foreign countries, so the development of renewable energy becomes an only survival way for Taiwan.

The so-called renewable energies include solar energy (further including solar photovoltaics and solar thermal energy), wind energy, hydropower, geothermal energy, ocean energies (such as ocean thermal energy conversion, tidal power, and wave energy, etc.), which are all natural energy resources coming from the sun or possessed by earth, other renewable energies also including biomass energies, such as waste energy, biogas electrification, and biofuel, etc. [4].

Although renewable energies are essentially exploited from nature, indigenous, and clean, and they are theoretically inexhaustible and sustainable, in the applying characteristics of renewable energies, several drawbacks do exist, such as low-energy density (in photovoltaic system, 9–10 m^2 of installing area is needed for each kilowatt of power), unstable supply (for example, clear day is the condition for solar electrification; for wind electrification, sufficient wind resource must be existed, and wind turbine can only be started at a specific range of wind speed, while blades must be stopped rotating when wind is too strong), and higher cost (for example, the installing expense for each kilowatt of PV is 300 thousands NT dollars, and its electrification cost is about 15–24 NT dollars for each kilowatt-hour, and the costs of other ways of RE electrification are also much higher than

Table 1
Global reserves and availability of major fossil energy resources [1]

Category	Oil	Natural gas	Coal
Item			
Total reserves (end of 2005)	1201 billion barrels	180 trillion cubic meters	909.1 billion tons
Yield (2005)	29.6 billion barrels	2.8 trillion cubic meters	5.45 billion tons
Available years	41 years	64 years	167 years

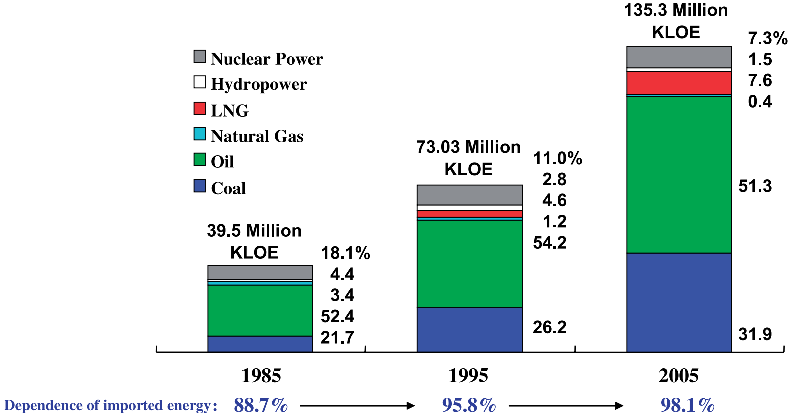


Fig. 1. Taiwan's energy supply structure [5].

those of traditional ways of electrification). So, when applying renewable energies, local conditions must be cooperated, such as solar radiation, wind power potential, available land area, and suitable sites, etc., which must be assessed before installing any kind of renewable energy system. Therefore, under these conditions of insufficiently economic impetus at present stage, the development and promotion of each category of renewable energies must depend upon each individual incentive or subsidizing scheme, by which a government may promote her corresponding RE policy in a much easier and effective way.

2. Taiwan's energy situation and status of RE development

Taiwan, Republic of China, with land area of 36,190 km^2 and population of 22.6 millions, has the world's second highest population density, i.e. 625 capita per km^2. Over the last two decades, the rapid economic growth has created substantial changes in the economic structure: GDP rose from US$52.4 billion to US$295.9 billion, and per capita BNP increased from US$2832 to US$13,157, with average growth rate of 6%. Sixty-seven percent% of GDP is now from service sector vs. 48% in 1983.

Please refer to Fig. 1. Due to the shortage of indigenous energy, more than 98.1% of total energy supply is imported. Imported crude oil is the major portion of energy supply, and 76.7% of which is from the Middle East. During 1985–2005, as shown in Fig. 2, the average annual growth rate of energy consumption is 5.9%, with an increase of electricity's

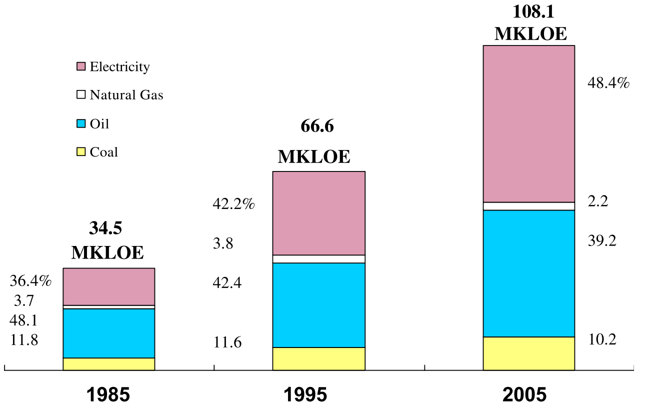


Fig. 2. Taiwan's energy consumption (by energy forms) [5].

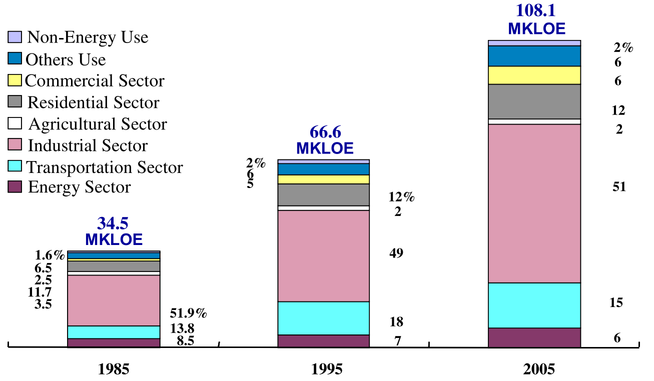


Fig. 3. Taiwan's energy consumption (by sector) [5].

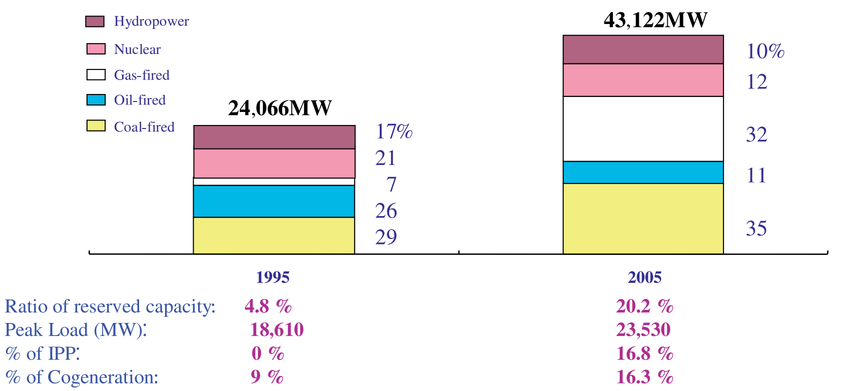


Fig. 4. Installed capacity of electricity generation [5].

Table 2
Current status, targets and promotion strategies for RE in Taiwan

Renewables	Year				Promotion strategies for the achievement of targets set for each RE by 2010
	2005		2010		
	Current status [5]		Targets		
	Installed capacity (MW)	Share of total (%)	Installed capacity (MW)	Share of total (%)	
1 Hydropower	1910	4.43	2168	4.22	• To promote 5 hydropower generation projects by Tai-power Company, with total installed capacity of 171MW • To promote 6 hydropower generation projects by private sector, with total installed capacity of 72MW • To provide private sector the information for small hydropower generation if no impact on ecological environment
2 Wind power	24	0.06	2159	4.20	• To remove obstacles for the projects in progress • To locate potential wind sites • To review incentive measures for enhancing the development of wind energy
3 Solar photovoltaics	1.0	0.002	21	0.04	• To promote the demonstration projects including the "Solar City", and the public buildings • To establish solar PV system for remote areas • To develop PV industries
4 Geothermal	—	—	50	0.10	• To assist local government in exploring geothermal energy • To assist local government in developing the geothermal project in aspects of finance and technology
5 Biomass	723	1.68	741	1.44	• To promote the district RDF (Refuse Derived Fuel) system for waste treatment and power generation • To assist the sale of biogas power in premium rate • To assist private enterprises in establishing power plants fueled by agricultural wastes such as rice husk • To promote industrial waste RDF-fueled power generation , especially in paper mills
Total	2,657	6.17	5,139	10.0	
Target share for renewable energy in terms of installed capacity of the total	6.17%		10.0%		

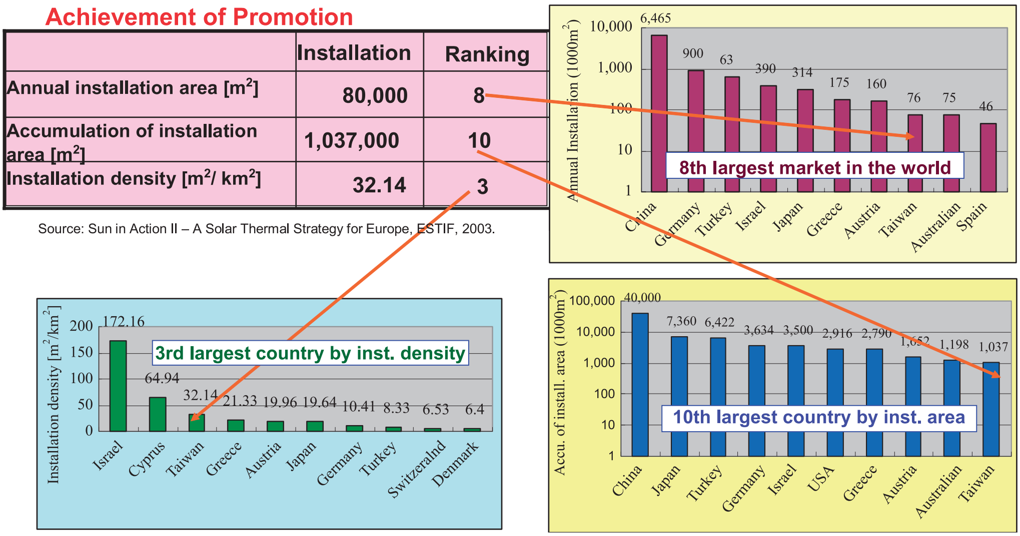


Fig. 5. Promotion achievement of solar water heater in Taiwan [7,8].

share and a decrease of oil's share, while the average annual growth rate of GDP is 6.2%. In Fig. 3, as the comparison among sectors, the shares of energy consumption in commercial and residential sectors increase. In the meantime, during 1995–2005, as Fig. 4 shows, the average annual growth rate for total installed power capacity is 3.1%, while average annual growth rate for power peak load is 1%. It is obvious that rapid economical progress is followed by higher energy demand during the last two decades in this country. Basically, Taiwan, a subtropical island in the Pacific Ocean rim, possesses abundant renewable energy sources, and it is disadvantageous to ignore them, if she wants to maintain her economic superiority continuously.

According to the data of BOE [6], as shown in Table 2, the installing status of renewable energies in Taiwan for 2005 is described as followings: 1910 MW for hydropower generation; 24 MW for wind power generation; 1.0 MW for photovoltaic system; 723 MW for biomass electrification; the aforementioned data summation is 2658 MW, share of which is 6.17% of the national power capacity in 2005. In addition to RE-electrification, solar water heater (SWH) is the most successful story for the development of RE in Taiwan. As shown in Fig. 5, Taiwan is the eighth largest market with 80,000 m^2 of annual installation area, the tenth largest country with 1,037,000 m^2 of cumulated installation area, and the third largest country with 32.14 m^2/km^2 installation density for SWH in the world [7,8].

3. Promotion strategies for renewable energy in Taiwan

According to the meeting conclusion of National Energy Conference, Sixth National Science and Technology Conference, Twentieth Science and Technology Advising Conference, and Nuclear-free Homeland National Conference, and taking into consideration factors including utilization potentials, developmental and technical viability, investment costs, promotional subsidies and the effects of these measures on the electricity rate structure, as well as the stability of the electrical network and the



Fig. 6. Asia's biggest single wind farm, of 49.8 MW, installed along the western coast of Miaoli County, Taiwan [9].

establishment of indigenous renewable related industries, a new more aggressive target has been proposed. This new target aimed at a 10% of total installed electrical power generation capacity to be delivered from renewable powers by 2010, with a total installed renewable power of 5,139 MW (see Table 2). According to the contents of Table 2, it may find that wind power is the most important and crucial item, because it occupies major share in total target capacity and its progress is far lagging behind. There are, however, many relative projects undergoing and executed by domestic and international companies. For example, InfraVest GmbH cooperated with Tai-power Company had just finished a wind power project of 49.8 MW along the coast of Miaoli County in June 2006, and which is the largest single wind farm in Asia so far [9] (see Fig. 6). Wind farms of more than 600 MW will be further erected along the western coast of Taiwan in the next 3 years according to the plans scheduled by BOE [10]. Therefore, it is considerably optimistic that the installed target of wind power electrification and thereby that of renewable electrification, i.e., 2159 and 5139 MW, will be respectively met by 2010.

The current promotional measures are summarized in Table 3. It is important to note that the fixed feed-in tariff adopted by Taiwan government is NT$ 2 kWh^{-1} (equivalent to EUR 0.05 kWh^{-1}), which is much lower than the average level of EU [11], because the domestic electricity rate is only about EUR 0.06 kWh^{-1}, which is among the cheapest electricity rates in the world and this is the reason why relatively expensive RE electrification apparatus, particularly solar PV system, is difficult to be deployed in Taiwan, while cost-competitive wind power is much more popular here.

The backbone of the strategy for promotion of renewable energy formulated by the BOE is to create a favorable developmental environment to achieve the scheduled targets, and to facilitate the deployment of renewable energy apparatus in Taiwan while foster the establishment of local related industries. In addition, in order to iron-out and remove non-technical barriers, the "Renewable Energy Promotion Plan" (REPP) was drafted and approved by the Executive Yuan in January 2002. There are 8 guiding strategies:

(1) to establish a higher level inter-ministerial coordinating mechanism,
(2) to draft and push for the passage of "Renewable Energy Development Bill" (REDB) and related regulations,
(3) to set up a favorable fixed feed-in tariff for renewable powers,

Table 3
Current incentive measures for the promotion of renewable energy in Taiwan

Type	Incentives	Current status [6,7]
Solar water heater (SWH)	Solar water heater (system) subsidy program • Subsidy: NT$1500/m^2, based upon collector installed area	1. Total accumulated area of solar collector installed: 1,425,700 m^2 2. Energy saving: 0.095 MKLOE/year 3. Industrial annual yield: NT$ 1 billion/year. 4. Total cumulated industrial yield: NT$ 15 billion 5. CO_2 emission reduction: 0.269 Million ton/year
Solar PV	Solar PV system demonstration program • Subsidy : NT$150,000/kWp • Subsidy Ceiling : 50% of Installation Cost	There are 91 demonstration projects with installed capacity of 785 kW (October, 2005)
Geothermal	Geothermal energy demonstration Program • Subsidy ceiling : 50% of exploration costs	MOEA is currently sponsoring Ilan County to build a geothermal plant. Preliminary planning shall be a 5000 kW demo project (depending on exploration outcome)
Electricity Purchase Program	Tai-power renewable energy premium purchase program	1. Fixed feed-in tariff is NT$ 2 kWh^{-1} 2. The approved capacity has reached 99 MW 3. Total purchase capacity will be 600 MW
Tax incentives	Statute for upgrading industries Business entities purchasing energy saving equipment or using new energy equipment or Technology investment tax credits	1. Business entities investing in new and clean energy can enjoy tax credit no more than 11% of equipment costs 2. Investing in new and clean industry energy can enjoy income tax credit, ranging from 10% to 20% of stock purchase price 3. Two-year's accelerated depreciation 4. Low interest rate loans: no more than 2-year postal floating saving interest rate, plus 2.45%
	Customs duty	Duty exemption for imported equipment without manufacturing domestically

(4) to provide tax and investment incentives,
(5) to provide sufficient interim budget and funding,
(6) to increase demonstrations and promotional activities,
(7) to establish renewable energy database, and
(8) to enhance RD&D in renewable technology and products.

Being coupled with these strategies are 24 promotional measures. The REPP coordinates actions by 13 central government ministries and local government agencies, with the following five main focal points:

(1) *Demonstrations and promotional measures*: Several incentive measures have been instituted as interim means to subsidize renewable energies (see Table 3).

(2) *Tax and investment incentives*: According to "Statute for Upgrading Industries", the business entity that invests RE apparatus is preferentially provided with tax credit no more than 11% of equipment costs, income tax credit ranging from 10–20% of stock purchase price, low interest rate loans and 2-year's accelerated depreciation.
(3) *R&D for renewable energies*: To develop highly efficient, low-cost and mass-producible renewable energy application technologies and products.
(4) *Coordinating mechanism*: Through a high-level inter-ministerial coordinating mechanism, all institutional non-technical barriers encountered by renewable energy developers are facilitated and resolved in a systematic manner.
(5) *A fixed feed-in tariff*: An interim measure to purchase renewable power at NT$ 2 kWh (~EUR 0.05 kWh) has been approved by state-owned Tai-Power company up-to 600 MW.

As shown in Fig. 7, according to the framework and contents of "Renewable Energy Development Bill" drafted by Executive Yuan [12], the essence of promotion strategies for renewable energies in Taiwan can be summarized as follows:

(1) In the medium term, the renewable energies shall contribute 10%, in terms of installed capacity by 2010.
(2) Wind technology is relatively mature and will be the major renewable energy in the near term. Meanwhile, the government shall continue to promote other renewable energies such as geothermal, biomass and hydropower to utilize renewable resources in all aspects.
(3) Solar photovoltaic (PV) product is booming in current energy market worldwide. The promotion of PV shall focus on strengthening R&D capability and developing related industries for cost reduction.
(4) In the long term, the ratio of renewable energy to total energy supply is projected to increase from 1% in 2003 to 4% in 2020.

4. Future perspective

To meet aforementioned targets set for the development of RE in Taiwan in both near and long terms, BOEMOEA has addressed three executive principles as following:

(1) Building up the framework for renewable energy development:
  - accelerating the enactment of "Renewable Energy Development Bill" to establish a sustainable environment;
  - adjusting the premium tariffs for renewable energies and rationalizing prices of fossil fuels by counting their external costs;
  - removing the obstacles in grid connection and power transmission to promote the power generation from renewable energy sources.
(2) Assisting the development in renewable energy industries:
  - enlarging the renewable energy market to encourage related industries and improve technology capability.
(3) Strengthening R&D:
  - accomplishing the targets by improving renewable energy technologies.

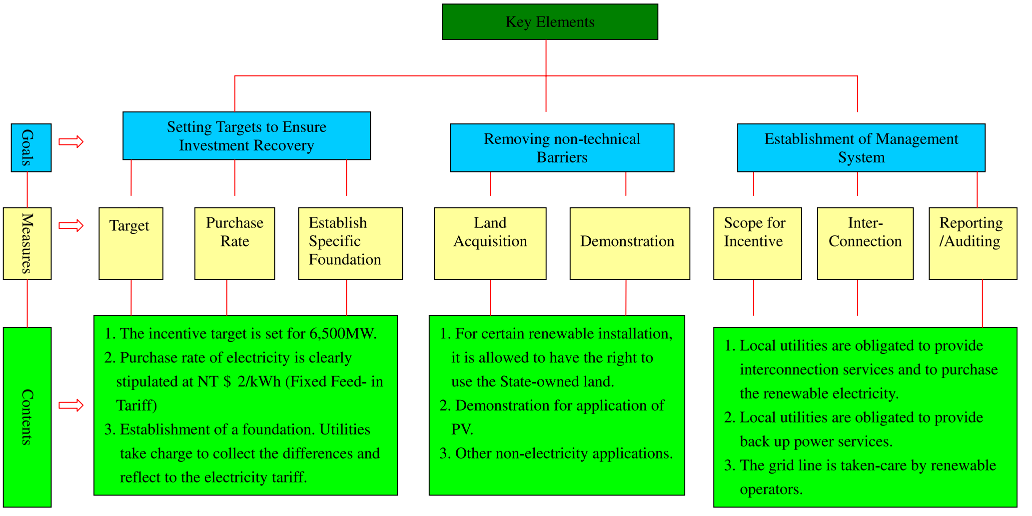


Fig. 7. Framework and contents of renewable energy development bill (draft) [12].

5. Conclusion

In the future, under suitable planning and promotion, significant growth in new and renewable energy utilization can be expected. The promotion of renewable energies would, however, require breakthrough in various regulations (e.g. land-use, building codes, grid-connection standards etc.), which require inter-agency coordination mechanism to overcome multiple barriers. To speed up the utilization of RE and deregulation of electric utilities, and the commitment on the execution of "Renewable Energy Promotion Plan", the rapid passage of "Renewable Energy Development Bill" and revision to the "Electricity Law" are among the most important actions to be undertaken by the government. In today, a clear and definite commitment to RE development has been given, with good progress. Taiwan is hoping that by actively implementing these action plans mentioned above, the energy diversity shall be promoted, the environmental quality shall be improved and the development of industries shall be triggered. The ultimate goal is to achieve environmental protection, energy security and economic growth, namely the so-called "triple-win" situation.

Acknowledgments

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